Simpson®

INSTRUMENTS THAT STAY ACCURATE

OPERATOR'S MANUAL

SIMPSON 420
FUNCTION GENERATOR

⚠ WARNING

READ AND UNDERSTAND THIS MANUAL BEFORE USING THE INSTRUMENT.

Failure to understand and comply with the WARNINGS and operating instructions can result in serious or fatal injuries and/or property damage.

SIMPSON ELECTRIC COMPANY
853 Dundee Avenue, Elgin, Illinois 60120-3090
(312) 697-2260 • Telex 72-2416 • Cable SIMELCO
IN CANADA: Bach-Simpson, Ltd., London, Ontario
IN ENGLAND: Bach-Simpson (U.K.) Ltd., Wadebridge, Cornwall

Warranty

SIMPSON ELECTRIC COMPANY warrants each instrument and other articles of equipment manufactured by it to be free from defects in material and workmanship under normal use and service, its obligation under this warranty being limited to making good at its factory any instrument or other article of equipment which shall within 90 days after delivery of such instrument or other article of equipment to the original purchaser be returned intact to it, or to one of its authorized service stations, with transportation charges prepaid, and which its examination shall disclose to its satisfaction to have been thus defective; this warranty being expressly in lieu of all other warranties expressed or implied and of all other obligations or liabilities on its part, and SIMPSON ELECTRIC COMPANY neither assumes nor authorizes any other persons to assume for it any other liability in connection with the sale of its products.

This warranty shall not apply to any instrument or other article of equipment which shall have been repaired or altered outside the SIMPSON ELECTRIC COMPANY factory or authorized service stations, nor which has been subject to misuse, negligence or accident, incorrect wiring by others, or installation or use not in accord with instructions furnished by the manufacturer.

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OPERATOR'S MANUAL

SIMPSON 420 FUNCTION GENERATOR

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Part No. 6-111940

WARNING

This Instrument is designed to prevent accidental shock to the operator when properly used. However, no engineering design can render safe an instrument which is used carelessly. Therefore, this manual must be read carefully and completely before making any measurements. Failure to follow directions can result in a serious or fatal accident.

SHOCK HAZARD: As defined in American National Standard, C39.5, Safety Requirements for Electrical & Electronic Measuring & Controlling Instrumentation, a shock hazard shall be considered to exist at any part involving a potential in excess of 30 volts rms (sine wave) or 42.4 volts DC or peak and where a leakage current from that part to ground exceeds 0.5 milliampere, when measured with an appropriate measuring instrument defined in Section 11.6.1 of ANSI C39.5.

NOTE: The proper measuring instrument for the measurement of leakage current consists essentially of a network of a 1500 ohm non-inductive resistor shunted by a 0.15 microfarad capacitor connected between the terminals of the measuring instrument. The leakage current is that portion of the current that flows through the resistor. The Simpson Model 229-Series 2 AC Leakage Current Tester meets the ANSI C39.5 requirements for the measurement of AC leakage current and can be used for this purpose. To measure DC Leakage current, connect a 1500 ohm non-inductive resistor in series with a Simpson 0-500 DC microammeter and use this as the measuring instrument.

SAFETY SYMBOLS

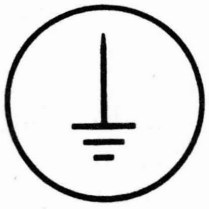
This marking adjacent to another marking or a terminal or operating device indicates that the Operator must refer to an explanation in the Operating Instructions to avoid damage to the equipment and/or to avoid personal injury.

WARNING

The WARNING sign denotes a hazard. It calls attention to a procedure, practice, or the like, which if not correctly performed or adhered to, could result in personal injury.

CAUTION

The CAUTION sign denotes a hazard. It calls attention to a procedure, practice, or the like, which if not correctly adhered to could result in damage to or destruction of part or all of the Instrument.



GROUNDED TERMINAL (PROTECTIVE):
A terminal which must be connected to earth ground by the Operator or Installer prior to making any other connections to the equipment for personal protection from electrical shock.

TABLE OF CONTENTS

SECTION I

Introduction 1-1

1.1 General 1-1

1.2 Supplies and Accessories 1-1

1.3 Safety Considerations 1-2

1.4 Technical Data 1-2

SECTION II

Installation 2-1

2.1 General 2-1

2.2 Unpacking and Inspection 2-1

2.3 Shipping 2-1

2.4 Warranty 2-1

2.5 Power Source Requirements 2-2

2.6 Installation 2-3

SECTION III

Controls, Connectors and Indicators 3-1

3.1 General 3-1

SECTION IV

Operation 4-1

4.1 General 4-1

4.2 Safety Precautions 4-1

4.3 Operating Procedures 4-3

Table of Contents

SECTION V

Theory of Operation 5-1

5.1 General 5-1
5.2 Power Supply 5-1
5.3 Frequency Control and VCG 5-2
5.4 Current Source 5-2
5.5 Range-Hz Timing Capacitors 5-2
5.6 Control Gate 5-2
5.7 Buffer and Level Shifter 5-2
5.8 Comparator and Latch 5-2
5.9 TTL Buffer 5-3
5.10 Sine Converter 5-3
5.11 Waveform Selectors 5-3
5.12 Output Amplifier 5-3

SECTION VI

Applications 6-1

6.1 General 6-1
6.2 Microphone Testing 6-1
6.3 Filter Characterization 6-2
6.4 Phase-Locked Loop 6-7
6.5 Amplifier Evaluation 6-11
6.6 Other Applications 6-13

SECTION VII

Servicing Instructions 7-1

7.1 General 7-1
7.2 Cover Removal 7-1

Table of Contents

7.3 Battery Installation (420D only) 7-2
7.4 Battery Charging (420D) 7-2
7.5 Battery Care 7-2
7.6 Fuse Replacement 7-3
7.7 Care 7-3
7.8 Replacement Parts and Schematic Diagram 7-4

LIST OF TABLES

1-1 Technical Data 1-2
3-1 Controls, Connectors and Indicators 3-1
7-1 Replacement Parts 7-4

LIST OF ILLUSTRATIONS

1-1 Function Generator III
3-1 Front Panel Facilities 3-3
3-2 Rear Panel Facilities 3-4
5-1 Block Diagram 5-4
6-1A Microphone Testing 6-3
6-1B Polar Response of Microphone Types 6-4
6-2A Filter Testing 6-5
6-2B Amplitude and Phase Characteristics of High Pass and Low Pass Filters 6-6
6-2C Amplitude Responses of Bandpass and Band Reject Filters 6-9
6-3A Phase-Locked Loop Block Diagram 6-10

6-3B Phase-Locked Loop Performance 6-14
6-4A Amplifier Testing 6-15
6-4B Frequency Response 6-16
6-4C Channel Linearity Test-Triangular Waveform 6-17
6-4D Square Wave Testing 6-18
7-1 Schematic Diagram 7-11

NOTE: This Operator's Manual contains information essential to the operation of this Instrument. Therefore, it should be kept in a convenient place and used for reference as required. (See NOTES FOR THE RECORD at the back of this manual.)

FIGURE 1-1. FUNCTION GENERATOR

SECTION I
INTRODUCTION

1.1 GENERAL

1.1.1 The Simpson 420 Function Generator (hereafter referred to as the 420 or the Instrument) is a multiple waveform generator suitable for use in general electronic maintenance, production, school, and the laboratory. The 420 is capable of generating a sine, triangular or square waveform and TTL output simultaneously. The 1 to 10 frequency dial, in conjunction with seven frequency range switches, provides a wide frequency range (0.1Hz to 1MHZ) for all functions. The external VCG control and the continuously variable DC offset control, with OFF position, further increases the capability of the Instrument

1.1.2 The 420 is available in two versions: 420A is the standard instrument designed to operate from a 120, 220 or 240 volts AC (50-60Hz) power source (check rear panel designation) and the 420D is an optional version designed for either AC line operation, or battery operation using rechargeable nickel-cadmium cells. The battery can operate the Instrument for eight hours continuously. Recharging is automatic when the Instrument is in the OFF position and with the line cord connected to an AC power source. (Refer to paragraph 7.4 for precautions and instructions. Hereafter, all information and data applies to both Instruments.)

1.2 SUPPLIES AND ACCESSORIES

1.2.1 All supplies and accessories required for the operation of the 420A and 420D are furnished with each instrument and are listed in Table 1-2. (Available replacement parts are in Section VII.)

1.3 SAFETY CONSIDERATIONS

1.3.1 This operator's manual contains cautions and warnings alerting the user to hazardous operating and servicing conditions. This information is flagged by CAUTION and WARNING headings throughout this publication, where applicable, and is defined at the front of the manual under SAFETY SYMBOLS. To ensure the safety of operating and servicing personnel and to retain the operating conditions of the Instrument, these instructions must be adhered to.

1.4 TECHNICAL DATA

1.4.1 Table 1-1 lists the technical data for the 420A and 420D under the reference conditions of 23°C ±1°C ambient temperature and 30 – 60% relative humidity.

TABLE 1-1. TECHNICAL DATA

1. GENERAL

Basic Outputs:	Sine, triangle, square, DC and TTL (square wave separate BNC Connector).
Frequency Range:	0.1Hz to 1MHz in seven ranges.
Output Amplitude:	20V p-p open circuit (10V p-p into 600 ohms).
Output Amplitude Control:	Continuously variable over a 30dB range. With 0/-30 db fixed attenuation switch.
VCG Input:	±20V maximum, 2kΩ input resistance. Frequency decreases from dial setting with negative voltage.
DC Offset:	Continuously variable with OFF position.

2. SPECIFICATIONS

Dial Accuracy:	±5% F.S.
Sine Wave Distortion:	1% (max.) 1 Hz to 100 kHz. 2% (max.) at all other frequencies.
Triangle Wave Non-Linearity:	1% (max.) up to 100 kHz.
Square Wave Rise/ Fall Time:	100 ns (max.) into 600 ohms 20pF.
Square Wave Non-Symmetry:	1% (max.) up to 100 kHz.
VCG Range:	300:1 with 0 to –5V external signal, with 1000:1 capability.
TTL Output:	Fixed TTL compatible output will drive up to 10 TTL loads. 25 ns -rise/fall time.
DC Offset:	Continuously variable, maximum of ±10V open circuit or ±5V into 600 ohms (maximum VAC + VDC without clipping). OFF position is provided.
Output Resistance	600 ohms, ±5%.
Amplitude Flatness: (sine wave)	±0.1 dB 0.1 Hz to 20 kHz. ±0.3 dB at all other frequencies.
Square Wave Aberration:	3% (max.)

3. TEMPERATURE STABILITY (after 15 minutes warm-up time)

Frequency:	±0.1% / °C
Amplitude:	±.05 db/ °C

4. **LINE VOLTAGE STABILITY**

Frequency:	±0.1% per ±10 VAC Variation.
Amplitude:	±0.05 dB per ±10 VAC Variation.

5. **TEMPERATURE RANGE**

Operation:	0 to +50°C.
Storage:	–10 to +60°C.

6. **POWER REQUIREMENT**

AC Operating or Battery Charging:	120 VAC, 220 VAC, or 240 VAC ±10% (check rear panel designation), 50-60 Hz 6 VA nominal.
Battery Operation:	Four nickel-cadmium "C" size rechargeable batteries. Eveready type CH 1.8 or equivalent (each battery is rated at 1.25V, 1.8 ampere-hours). (NOTE: Batteries are not furnished with the Instrument.)
Operation Time (continuous) with fully charged battery:	8 hours nominal.
Recharge Time:	16 hours nominal.

7. **DIMENSIONS**

Height:	2.70 in (68.6mm).
Width:	8.40 in (213.4mm).
Depth:	9.00 in (288.6mm).

8. **WEIGHT** 3 lbs. (1.36 kg), 420A

4 lbs. (1.82 kg.), 420D with batteries.

TABLE 1-2. ITEMS AND ACCESSORIES FURNISHED WITH THESE INSTRUMENTS

Quantity	Description	Number
1	Function Generator	
	420A, 120 VAC 50/60 Hz operation	12671
	or 420A, 220 VAC 50/60 Hz operation	12672
	or 420A, 240 VAC 50/60 Hz operation	12673
	or 420D, 120 VAC 50/60 Hz operation	12674
	or 420D, 220 VAC 50/60 Hz operation	12675
	or 420D, 240 VAC 50/60 Hz operation	12676
1	Operator's Manual	6-111940
1	Line Cord	5-118916

SECTION II
INSTALLATION

2.1 GENERAL

2.1.1 This section contains instructions for the installation and shipping of the 420. Included are unpacking and inspection procedures, warranty, shipping, power source requirements and installation.

2.2 UNPACKING AND INSPECTION

2.2.1 Examine the shipping carton for obvious signs of damage. Then inspect the Instrument for possible damage. If damage is noted, notify the carrier and supplier and do not use the Instrument. If the Instrument appears to be in good condition read operator's manual in its entirety. Become familiar with the Instrument as instructed in this manual, then proceed to check the electrical performance as soon as possible. Also, check that all items in Table 1-2 are included with the Instrument.

2.2.2 Save the shipping carton and packing materials for future storing or shipping of the Instrument.

2.3 SHIPPING

2.3.1 When returning the Instrument for warranty repairs, pack it carefully and ship it prepaid and insured to the proper destination.

2.4 WARRANTY

2.4.1 The Simpson Electric Company warranty policy is printed on the inside front cover of this manual. Read it carefully prior to requesting a warranty repair.

NOTE: For assistance of any kind, including help with the Instrument under warranty, contact the nearest Authorized Service Center (listed on the last pages of this manual). If it is necessary to contact the factory directly, give full details of any difficulty and include the Instrument model number, serial number (on the back of the Instrument) and date of purchase. Service or shipping instructions will be mailed promptly. If an estimate of charges for non-warranty or other service work is required, a maximum charge estimate will be quoted. This charge will not be exceeded without prior approval.

2.5 POWER SOURCE REQUIREMENTS

2.5.1 The 420A is designed to be operated from the AC line only. The 420D is designed to be operated from either the AC line or self-contained nickel-cadmium batteries (not furnished with the Instrument, but available from any local electronic parts distributor). (Refer to Table 1-1, item 6.)

2.5.2 AC Line Operation: The 420 is wired at the factory for 120 VAC (50 to 60 Hz) operation. To convert the Instrument for 220 or 240 VAC operation, consult the nearest Authorized Service Center.

CAUTION

For AC line operation, ensure that the grounding pin of the power plug is securely connected to an earth (powerline) ground. Use a 3-wire grounded outlet which conforms to the latest issue of the National Electrical Code.

2.5.3 Battery Operation (420D): Battery operation is automatic whenever batteries are installed, the line cord is disconnected, and one of the function switches set to a position other than the POWER OFF position. For battery installation and battery test refer to paragraph 7.3.

2.6 INSTALLATION

2.6.1 The Instrument may be set horizontally on its four rubber grommets or vertically on its back and operated in either position. The Instrument can also be set at an inclined angle by positioning the 8-position carrying handle under the unit. To set the Instrument at a desirable viewing angle, use the following procedures:

- Pull out both knobs (on sides) of Instrument.
- Rotate handle to one of eight positions.
- Push both knobs into a locking position.

SECTION III
CONTROLS, CONNECTORS AND INDICATORS

3.1 GENERAL

3.1.1 All controls, connectors, indicators and other operational items are described in Table 3-1, and shown in Figures 3-1 and 3-2. Become thoroughly familiar with the name and purpose of each item before operating the Instrument.

TABLE 3-1. CONTROLS, CONNECTORS AND INDICATORS

1. **Power Switch:**
   - ON — Applies primary POWER to the Instrument.
   - (OFF) — Disconnects primary POWER from all circuits except the battery charging circuit.

2. **Range-Hz Selector Switches:** Depressing one of the seven RANGE selector switches selects the output frequency in decades. In conjunction with the frequency dial setting, the output frequency will vary from 0.1 Hz to 1MHz. For example, if the FREQUENCY dial is set to 10 and the X100 RANGE switch is depressed, the output frequency is 10×100 Hz $= 1$ kHz.

3. **Waveform Selector Switches:** The WAVEFORM switches select the sine (∿), triangular (∿) or square (⊓) WAVEFORM which is available at the 600Ω OUTPUT connector.

4. **Attenuator 0/-30 dB Switch:** Pushing this SWITCH out will cause the amplitude of the output signal to be reduced by approximately – 30dB.

5. **Amplitude Control:** Controls the AMPLITUDE of the output signal. In conjunction with the 0/-30 dB SWITCH, the output signal can be attenuated by –60dB. (approximately).

6. **Frequency Dial:** The dial setting times the selected RANGE switch will give the output frequency at the TTL and 600Ω OUTPUT connectors.

7. **DC Offset**
   Control: Varies the DC component of the output signal at the 600Ω OUTPUT. The DC component of the output signal can be switched off by setting the control to the OFF position.

8. **TTL Output:**
   (BNC) A TTL-compatible square wave is available at this connector. The frequency is the same as the frequency of the waveform at the 600Ω OUTPUT. Changes AMPLITUDE control (5), OFFSET control (7) or 0dB/30 dB SWITCH (4) will NOT affect the TTL Output signal.

9. **Protective Ground:**
   (Binding Post) Provides connection of the Instrument to earth GROUND.

WARNING

For battery operation of the 420D, connect this terminal to an earth GROUND.

10. **600Ω Output:**
    (BNC) Signal selected by the WAVEFORM selector switches and the DC OFFSET voltage are available at this connector.

11. **VCG in Jack:** Controls the frequency of the selected signal by an external voltage input.

12. **LED Indication:** When the POWER ON-(OFF) switch is depressed, the LED illuminates. For the 420D, this indicates that the DC-DC converter is turned on.

    REMEMBER: As long as the 420D is plugged into AC line voltage, a constant current charges the rechargeable batteries continuously. The charging rate is about 165mA when the power switch is off and reduced to about 60mA while the power switch is ON.

13. **AC Power Receptacle:** This receptacle accepts the AC line power cord used for AC operation or battery charging.

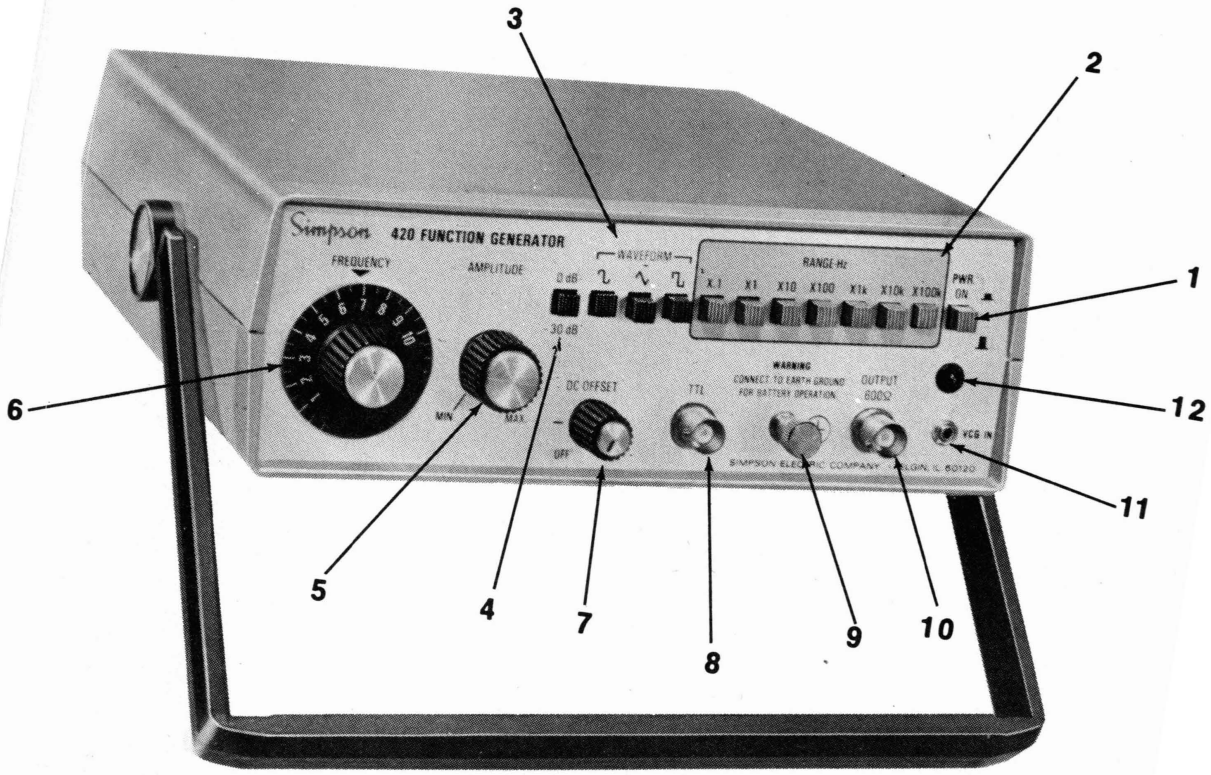


FIGURE 3-1. FRONT PANEL FACILITIES

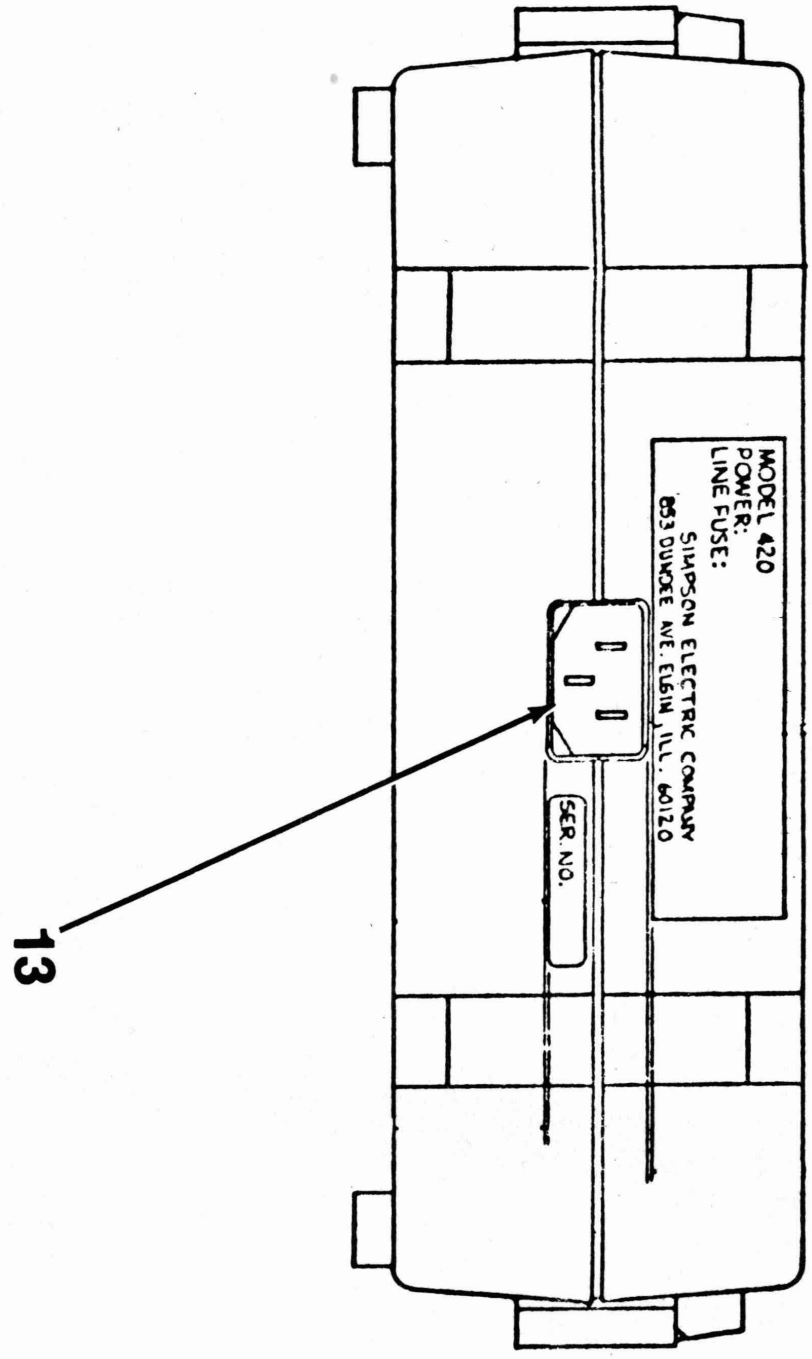


FIGURE 3-2. REAR PANEL FACILITIES

SECTION IV
OPERATION

WARNING

Before proceeding with the operation of the 420, review the Shock Hazard Definition at the front of this Manual.

4.1 GENERAL

4.1.1 This section of the manual contains information required to use and operate the 420 in a safe and proper manner. Special notes and instructions have been provided for added user safety and convenience.

4.2 SAFETY PRECAUTIONS

4.2.1 The 420 is intended to be used only by personnel qualified to recognize shock hazards and trained in the safety precautions required to avoid possible injury.

4.2.2 Do not work alone when making measurements or adjustments where a shock hazard can exist. Notify another (nearby) person that you are making, or intend to make such measurements.

REMEMBER: Voltages may appear unexpectedly in defective equipment. An open bleeder resistor can result in a capacitor's retaining a dangerous charge. Remove all power and discharge all capacitors in the circuit being measured before making connections or disconnecting the Instrument.

4.2.3 Locate all voltage sources and current accessibility paths before making any connections.

4.2.4 Before each use, inspect the test leads, probes, connectors, and power cable for cracks, breaks or crazes in the insulation. If any defects exist, destroy, and replace the defective item(s) immediately.

4.2.5 For maximum safety, test leads, circuit and Instrument should **not** be touched while power is applied to the circuit being measured.

4.2.6 When using the 420 be sure that it is connected to the three-wire powerline outlet that is correctly wired in accordance with the latest National Electrical Code. If the integrity of the powerline outlet is in doubt, or a three-wire to a two-wire cheater plug is used, then ground the Protective Ground binding post located along the lower edge of the front panel.

IMPORTANT

Do not exceed the maximum input voltage ratings of the 420 which are tabulated in Table 1-1 and 1-2. To do so endangers personal safety and may also damage the Instrument.

4.2.7 Do not attempt to float the grounded terminal (the Protective GROUND binding post and the body of the BNC input connector are electrically connected to the panel). To do so risks personal safety and may damage the 420 as well as the equipment under test. The protective GROUND binding post must be connected to earth GROUND when the Instrument is operated by battery with the AC line cord disconnected.

4.3 OPERATING PROCEDURES

4.3.1 Waveform Selection:

- Plug the Instrument into an AC power source, or install batteries in the 420D. Depress the POWER ON-(OFF) switch.
- Select one of the WAVEFORM switches. Corresponding waveform will be available at the 600Ω OUTPUT connector.

4.3.2 Frequency Selection:

- Select one of the seven RANGE-Hz switches. The output frequency is determined by the product of the dial setting and the depressed RANGE-Hz switch. For example, when the FREQUENCY dial is set at 5 and × 10 range depressed, the output frequency is 5 × 10 Hz = 50 Hz.
- The TTL output provides a square wave at the same frequency as the 600Ω OUTPUT.

4.3.3 Amplitude Adjustment:

- The amplitude of the selected output signal available at the 600Ω OUTPUT is adjusted by the AMPLITUDE control.
- The amplitude of the 600Ω OUTPUT signal will be attenuated approximately −30 dB by pushing the 0dB/ −30 dB SWITCH out.
- The TTL output amplitude is a fixed level. It is not affected by DC OFFSET, amplitude adjustment or 0dB/−30 dB ATTENUATOR.

4.3.4 DC Offset Control:

- With the DC OFFSET control off, the waveform at the 600Ω OUTPUT is symmetrical above ground.

- Continuously variable ±10 VDC open circuit, ±5 VDC into 600Ω. The unclipped signal swing of the generator is limited to ±10V (peak AC + DC) open circuit or ±5V (peak AC + DC) into 600Ω. For large DC offset applications an oscilloscope should be used to observe any undesired clipping.

4.3.5 DC Output Operation:

- Leave all of the WAVEFORM selection switches in the out position. (This is done by depressing the WAVEFORM switches slightly.)
- The output available at 600Ω OUTPUT becomes a DC voltage supply.
- The output level, controlled by the DC OFFSET control, is limited to ±10V circuit or ±5V into a 600Ω load. An external filter can be used to reduce the AC output impedance.

4.3.6 Voltage Controlled Generator (VCG) Operation:

4.3.6.1 The output frequency of the 420 can be varied by applying an external control voltage into the VCG IN jack. A positive (going) voltage will increase the output frequency while the negative voltage will decrease it. Due to the power supply limitation, the upper-frequency is limited to the upper-frequency dial. However, the lower-frequency limit has a wider control range. More than a 300:1 ratio from the maximum dial setting is achievable.

- Set the frequency dial to five and the RANGE switch to X10.
- Apply a 1 Hz sine or triangular waveform with ±2 V amplitude into VCG IN jack.
- The output frequency will vary up and down by a ratio of more than 300:1.

4.3.7 TTL Output:

- This is a TTL compatible square wave output which can be directly applied to any TTL circuit. The AMPLITUDE and DC OFFSET controls have no effect on this output. The frequency is determined by the FREQUENCY dial setting and the selected RANGE switch even when the generator is under DC output operation as described in 4.3.5.

SECTION V
THEORY OF OPERATION

5.1 GENERAL

5.1.1 The 420 (Figure 5-1) generates a basic triangular waveform signal by means of charging and discharging a capacitor by positive and negative current sources. A dual comparator and the associated latching circuit generates a signal to control the current sources. A square wave signal is derived from this control signal. A sine converter is used to convert a triangular waveform into a sine waveform. The output frequency depends upon the rate of charging and discharging a capacitor (Figure 5-1).

5.2 POWER SUPPLY

5.2.1 For 420A only:

- A positive full wave rectifier (D11 & D12) produces the unregulated +15V for regulators IC5 and IC6 to generate +12V and +5V respectively.
- A negative full wave rectifier (D13 & D14) supplies an input voltage for Q6 and IC7B to generate −12V.

5.2.2 For 420D only:

- A positive full wave rectifier (D18 & D19) produces a +9V unregulated power source for current source generator Q13 & IC9, to charge the batteries and power the DC-DC converter T2, Q14, and Q15.
- The DC-DC converter generates ±15V for ±12V regulators IC5 and Q6.
- A + 4.75V regulated power supply replaces the regulated +5V power source.

5.3 FREQUENCY CONTROL AND VCG:

- The FREQUENCY dial controls the rate of charging and discharging of a capacitor in order to vary the output frequency. The voltage applied into the VCG IN also serves the same function.

5.4 CURRENT SOURCE:

- The positive and negative CURRENT SOURCES IC2A, Q1 and IC7A, IC1 respectively, provide the charging and discharging of a timing capacitor.

5.5 RANGE-Hz TIMING CAPACITORS:

- Selecting one of these capacitors (C1 through C5) and IC2B, changes the output frequency in decade steps.

5.6 CONTROL GATE:

- Diode gates D3 and D4 control the current sources for a timing capacitor, depending upon the command of the CONTROL signal from latching circuitry IC4.

5.7 BUFFER AND LEVEL SHIFTER:

- For minimum loading a BUFFERING circuit consisting of Q2, Q3, and Q4 is used to provide a triangular wave signal pick-off point. A level shifter is required to produce symmetrical $\pm$ peak amplitudes.

5.8 COMPARATOR AND LATCH:

- The dual COMPARATOR IC3, detects the $\pm$ peak amplitudes of the triangular wave. When the positive peak is detected, IC4 latches to one of two states so

that the positive CURRENT SOURCE is turned off, allowing the timing capacitor to discharge by the negative CURRENT SOURCE and vice versa.

5.9 TTL BUFFER:

- The gate control signal is applied to one of the gates of IC4 to generate a TTL output.

5.10 SINE CONVERTER:

- The triangular wave signal drives the differential amplifier IC8 into a non-linear operating region to produce a low distortion sine wave. Trim pots VR6 and VR7 are used to adjust for minimum distortion.

5.11 WAVEFORM SELECTORS:

- Depress one of these switches (H, J, & K) to select one of the three WAVEFORMS available at 600Ω OUTPUT.

5.12 OUTPUT AMPLIFIER:

- The output amplifier, consisting of Q7 through Q11, provides enough amplification through amplitude control VR11 for the input signal from the WAVEFORM selector switch. The 600Ω OUTPUT can be reduced 30 dB depending upon the position of SWITCH 1.L. An external DC OFFSET control is also incorporated into the output amplifier in order to shift the baseline of the output signal wave up and down from zero potential.

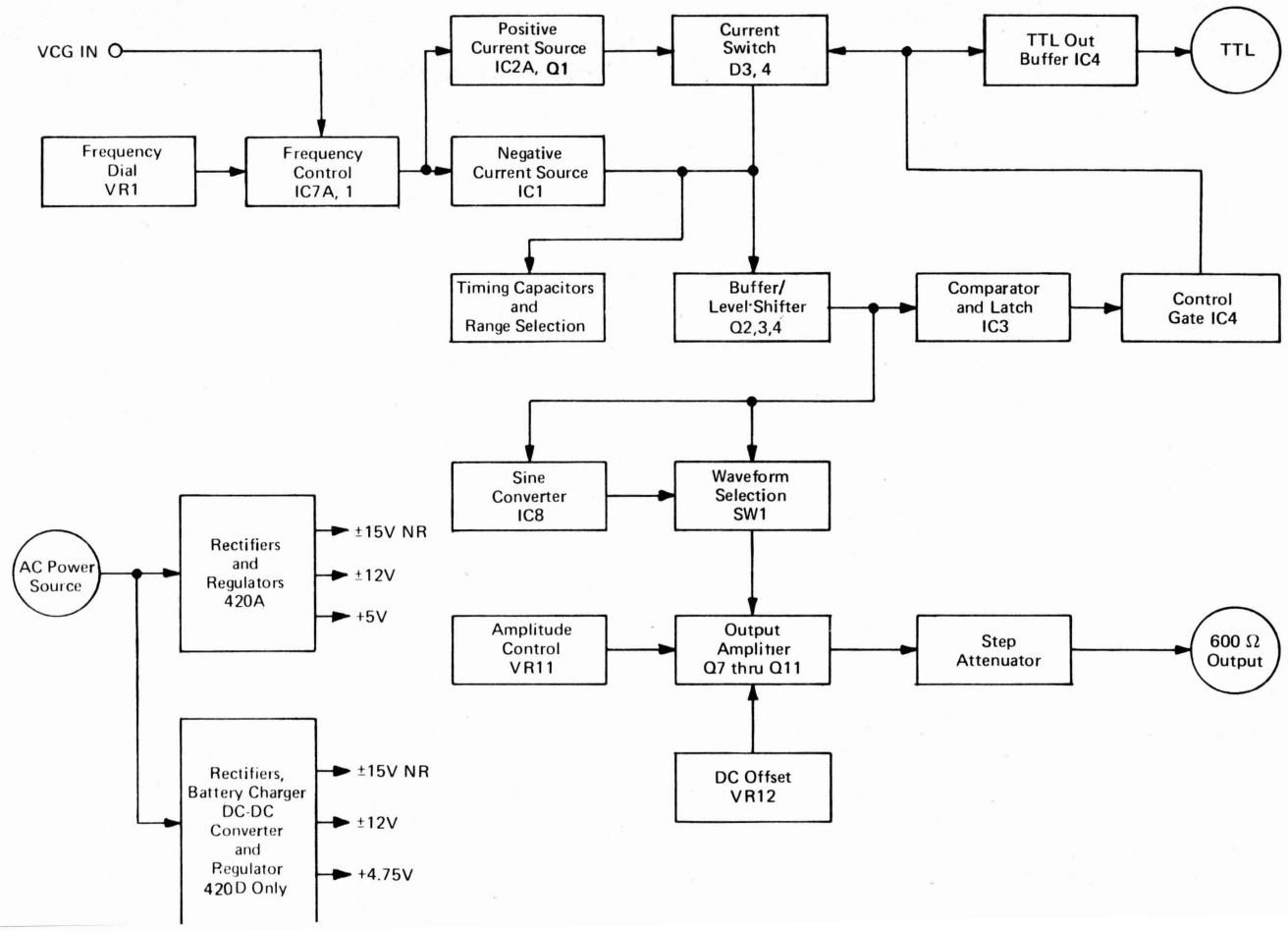


FIGURE 5-1. BLOCK DIAGRAM

SECTION VI
APPLICATIONS

6.1 GENERAL

6.1.1 The Simpson 420A and 420D Function Generators are general purpose signal sources. Both Instruments operate on AC power, while the 420D includes rechargeable nickel-cadmium battery operation.

6.1.2 Some fields of application for the 420 include: digital circuit design, communications and telemetry equipment, sound and vibration analysis, high-fidelity equipment, signal transducers, control and information display systems, production testing and instrument repair or calibration. The portability of the 420D is valuable for field servicing.

6.2 MICROPHONE TESTING

6.2.1 The sensitivity of a microphone to sound arriving at different angles can be determined by using the test procedure shown in Figure 6-1A. For best results all testing should be performed in an anechoic chamber or in a quiet area.

6.2.2. Three microphone categories are shown in Figure 6-1B. The omni-directional microphone responds equally well to sound originating from all directions. A bi-directional microphone will select sound in the front or back and will attenuate sound arriving from the sides. A uni-directional microphone only selects sound arriving directly in front of it.

6.2.3 Test Procedure: Connect equipment as shown in Figure 6-1A. Set the 420 at the desired sine wave test frequency. Adjust the output amplitude of the Instrument for a voltmeter

reading of +30dB. Use the oscilloscope to monitor the amplifier and power amplifier outputs for signal distortion, clipping or DC levels.

6.2.4 Rotate the microphone axis 30° CW in a horizontal plane. Plot the voltmeter's reading in dB along the 30° axis of the polar response graph. Continue this procedure at 30° intervals until the microphone has rotated 360°.

6.2.5 A family of response curves can be generated by repeating the procedure above at different test frequencies. This is illustrated in the omni-directional example (Figure 6-1B).

6.3 FILTER CHARACTERIZATION

6.3.1 It is possible to characterize a filter by examining its amplitude and phase vs frequency characteristics. A passive filter utilizes resistors and reactive components only. An active filter includes transistors or operational amplifiers to selectively amplify or attenuate frequency components of the incoming signal.

6.3.2 Test Procedure: The amplitude and phase of a filter can be determined by using the test arrangement in Figure 6-2A. Set the 420 to a frequency that is within the pass-band of the filter to be tested. Adjust the amplitude of the Instrument for a reading of +10dB. Connect the voltmeter to the filter output, and record that value. Subtract the value of the filter input from the filter output to determine the filter's gain in dB.

6.3.3 Slowly vary the frequency of the Instrument toward the stop band. Record the frequencies at which the phase changes by 10° increments. The cut-off frequency is defined at the point where the filter output is —3dB below the value in the pass-band. Also, record the frequencies at which the filter output is down by –10dB increments.

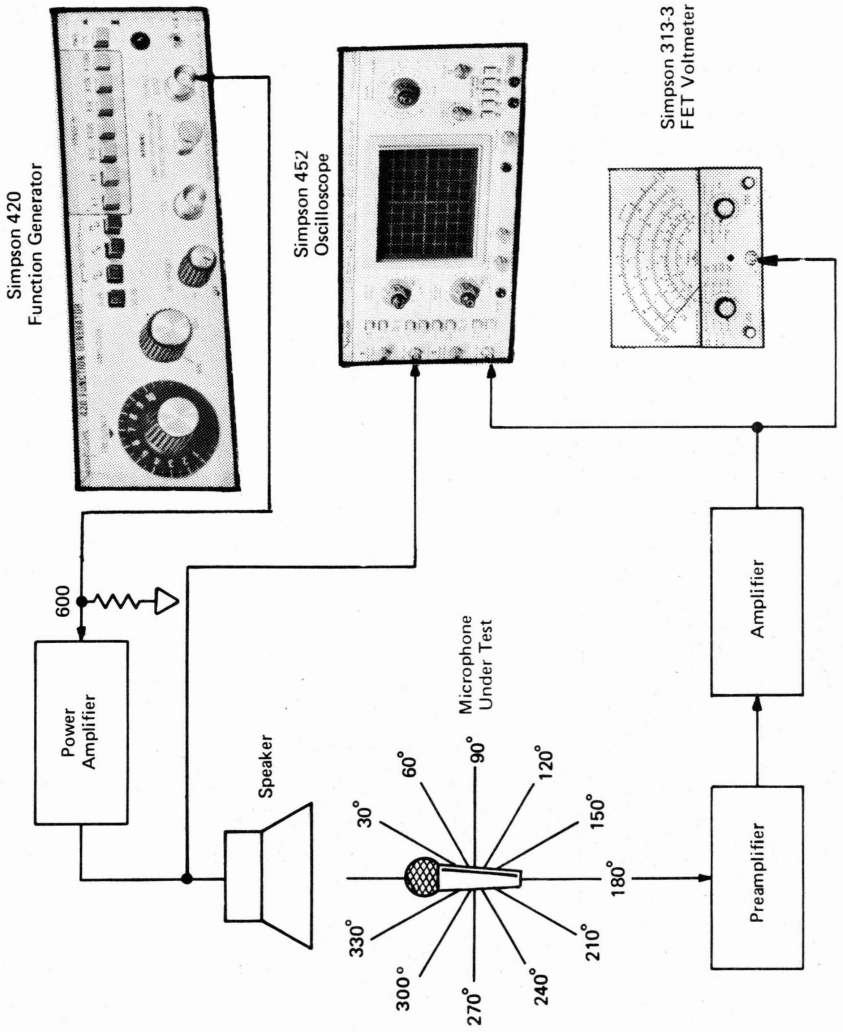
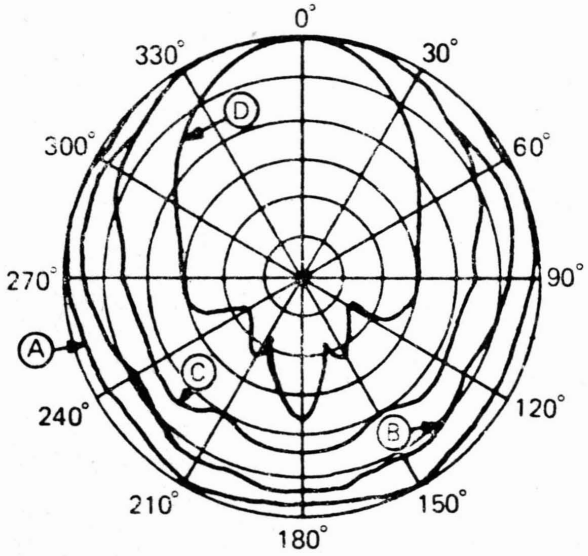


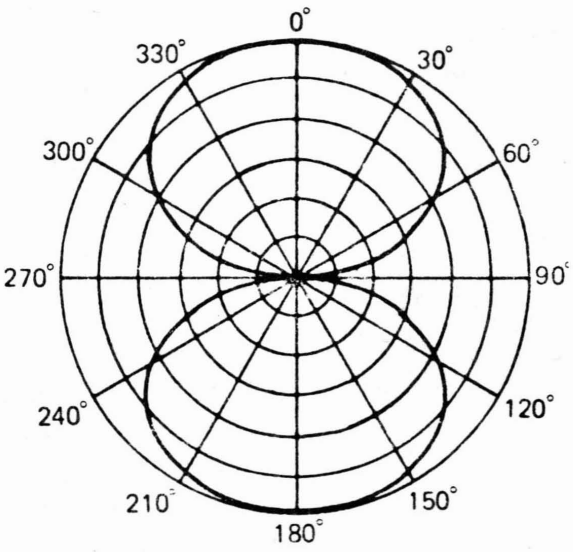
FIGURE 6-1A. MICROPHONE TESTING



SCALE IS 5 DECIBELS PER DIVISION

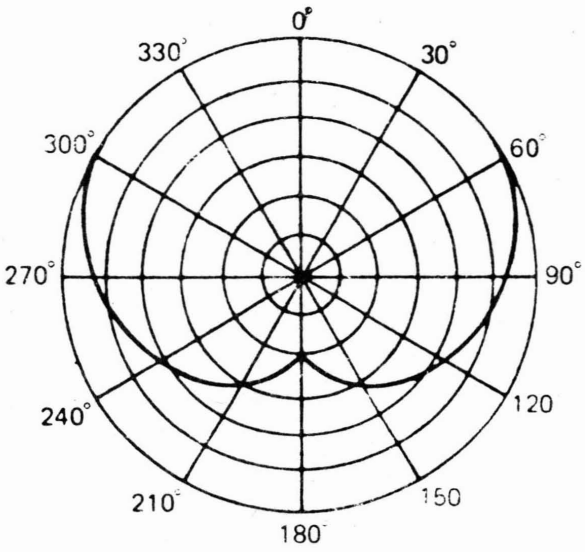
A = 1000 C = 4000
B = 2000 D = 8000

OMNI-DIRECTIONAL



SCALE IS 5 DECIBELS PER DIVISION

BI-DIRECTIONAL



SCALE IS 5 DECIBELS PER DIVISION

UNI-DIRECTIONAL

FIGURE 6-1B. POLAR RESPONSE OF MICROPHONE TYPES

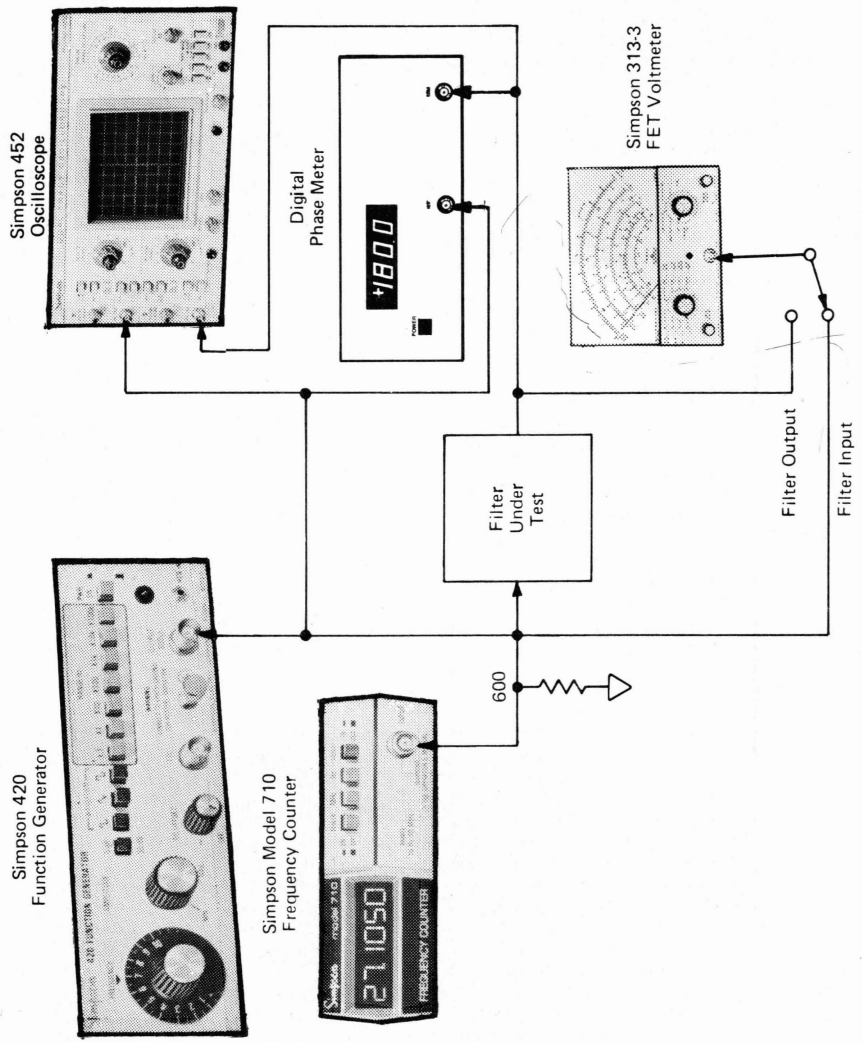


FIGURE 6-2A. FILTER TESTING

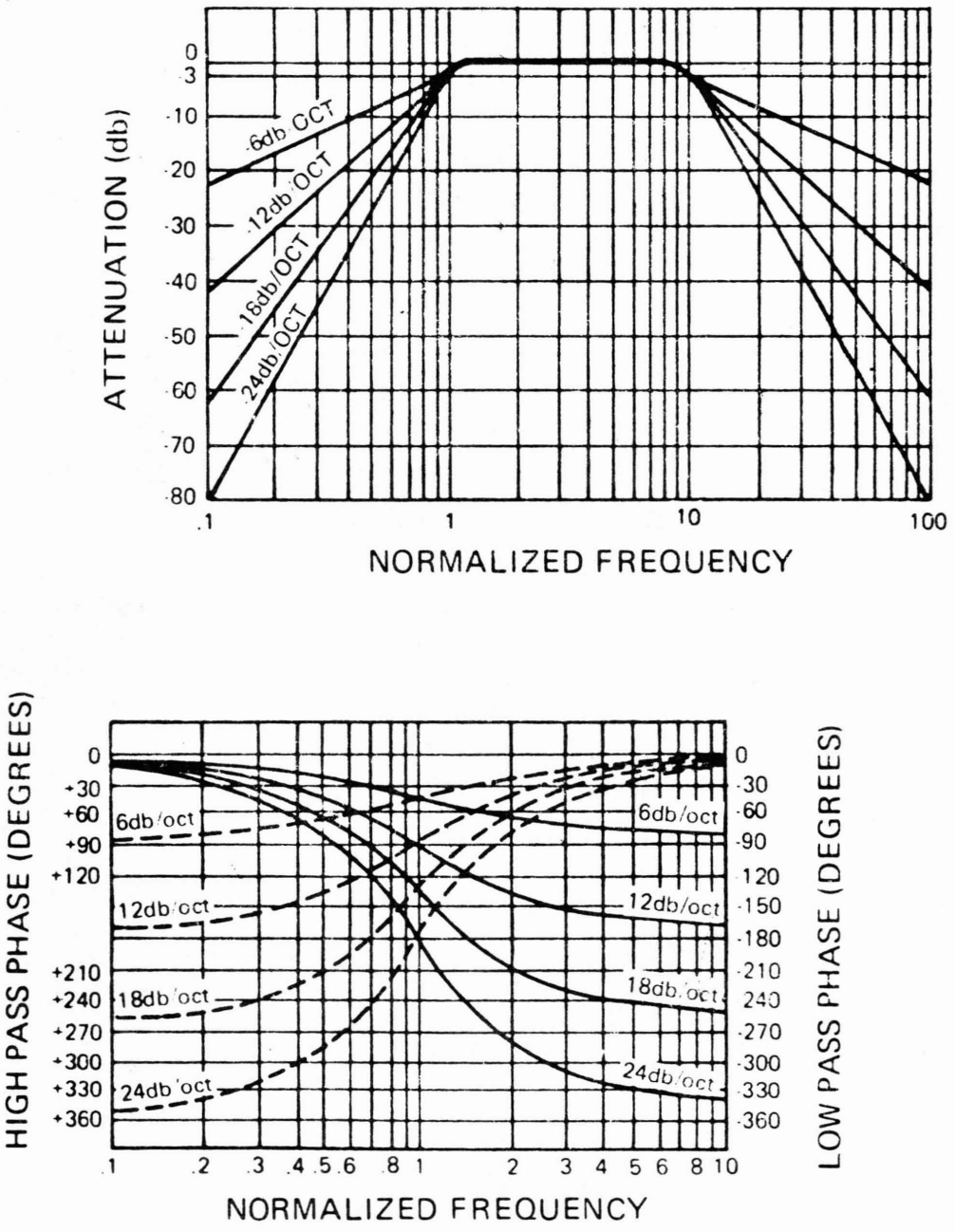


FIGURE 6-2B. AMPLITUDE AND PHASE CHARACTERISTICS OF HIGH PASS AND LOW PASS FILTERS

6.3.4 Figure 6-2B shows the amplitude and phase characteristics of all the filters in 0dB or unity. The order of a filter is determined by the rate of attenuation in the stop band. A first order filter has a slope of 6dB/octave or 20dB/decade (an octave above the frequency f is given by $f/2 < f < 2f$. A decade is from f to 10f). The amplitude and frequency axis of Figure 6-2B have been normalized. This is accomplished by subtracting 10dB from all amplitude readings and by dividing the frequency axis by the cut off frequency.

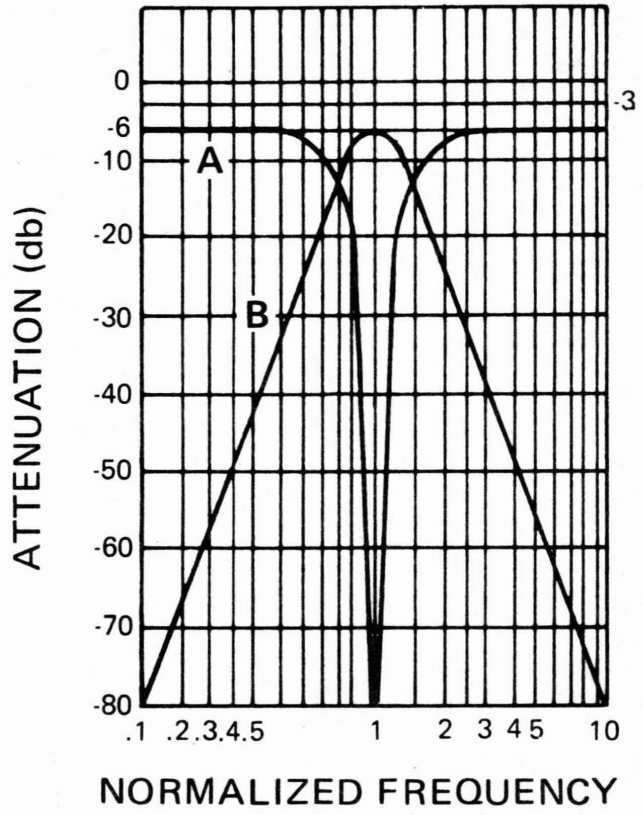
6.3.5 Figure 6-2C shows the amplitude responses of band-pass and band-reject filters. Notice that the amplitude within the pass-band is –6dB for both filters. The gain of the filters is therefore ½ (6dB = 0.5). This is referred as a 6dB insertion loss. A quality factor is defined for the band-pass and band-reject filters to qualitatively describe the degree of the filter's frequency selectivity. The quality factor is defined as $Q = \frac{fc}{BW}$ where fc is the filter's center frequency and BW (bandwidth) is the frequency difference between the upper and lower –3dB frequencies.

6.4 PHASE-LOCKED LOOP

6.4.1 A phase-locked loop is a device that can provide an output signal frequency equal to another frequency source, and follow or track any frequency deviations of the source within a specified range. Phase-locked loops are used in FM receivers to automatically lock on and track the carrier frequency. It is also used in serial data transmission to recover the clock frequency.

6.4.2 A block diagram of a phase-locked loop is given in Figure 6-4A. The phase-locked loop phase comparator continuously adjusts the frequency of its VCO until it is the same as the source oscillator. Two parameters of interest are the phase-lock range and the capture frequency range. The phase-lock range is the range of frequencies over which the phase-lock loop remains phase-locked, having been initially phase-locked. A capture frequency range refers to the range of frequencies over which the phase-locked loop can achieve a phase-locked condition when it was not initially phase-locked. It should be noted that the VCO of the phase-locked loop nearly returns to its center frequency (f_o) when it is in an unlocked condition (Figure 6-3B).

6.4.3 Test Procedure: The performance of the phase-locked loop can be determined by using the test arrangement in Figure 6-3A. Adjust the amplitude of the source oscillator to 1 V rms sine wave. Use the frequency counter to find the VCO's center frequency. Adjust the frequency of the source oscillator to this frequency to achieve a phase-locked condition. Gradually increase the frequency of the source oscillator until the phase-locked loop becomes unlocked and the VCO nearly returns to its center frequency (f_o). The frequency at which this occurs is called the maximum phase-lock frequency f_L (max.). Return the source oscillator to center frequency and phase-locked condition. Gradually decrease the source oscillator frequency until the phase-locked loop becomes unlocked. This will be the minimum phase-locked frequency f_L (min.). Thus, the phase-locked range is from f_L (min) to f_L (max.).



A = BAND REJECT
B = BAND PASS

FIGURE 6-2C. AMPLITUDE RESPONSES OF BANDPASS AND BAND-REJECT FILTERS

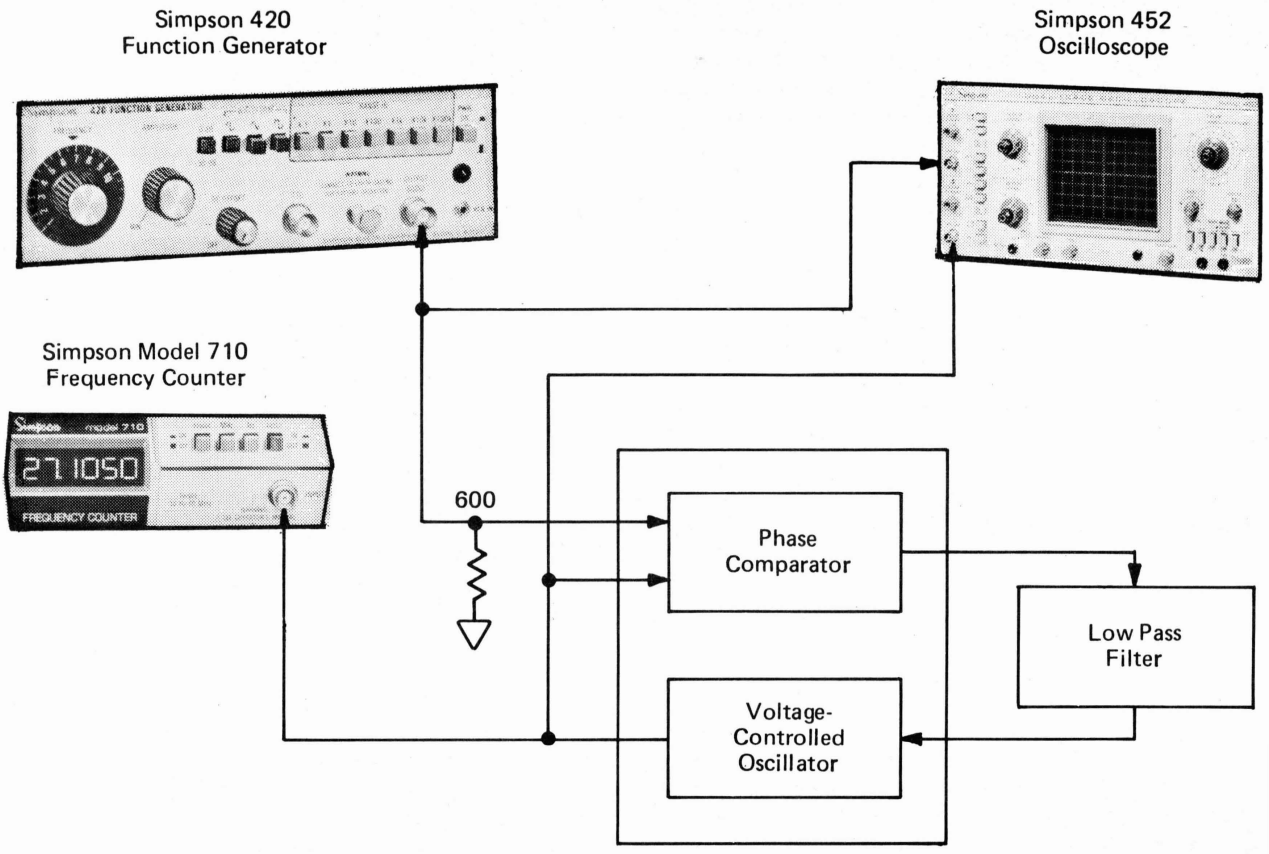


FIGURE 6-3A. PHASE-LOCKED LOOP BLOCK DIAGRAM

6.4.4 To determine the capture frequency range, adjust the source oscillator to any frequency above f_L (max).* Gradually decrease the frequency while monitoring the VCO output on the frequency counter. At some frequency below f_L (max) the VCO will increase its frequency and phase-lock with the source oscillator. This is called the maximum capture frequency f_c (max). Similarly adjust the source oscillator to a frequency below F (min) while monitoring the VCO output on the frequency counter. At some frequency above f_L (min)* the VCO will decrease its frequency and phase-lock with the source oscillator. This is called the minimum capture frequency f_c (min). Thus, the capture frequency range is from f_c (min) to f_c (max) (Figure 6-3B).

6.5 AMPLIFIER EVALUATION

6.5.1 Connect equipment as shown in Figure 6-4A. An appropriate load must be chosen for the amplifier. For a high-fidelity amplifier the load would be an eight ohm non-inductive resistance capable of dissipating the amplifier's full output power.

6.5.2 Test Procedure: To calculate the amplifier's gain and power output select a 0dB sine wave at 1kHz and minimum output amplitude. Turn the gain of the amplifier to maximum. Slowly increase the 420 output until output signal clipping is observed on the oscilloscope. Use the equation $P=V^2/R$ where P is output power in watts, V is output voltage in ACV rms and R is the resistance of the load to calculate the maximum output power. Subtract the amplifier input voltage in dB from the output voltage to obtain amplifier gain in dB.

**Since the VCO can be locked into the harmonic of PLL input signal, the starting frequency of the source oscillator should be just slightly over or under VO's lock in range. Locking into the harmonic of the input signal is one of the methods for frequency multiplication.*

6.5.3 To calculate the amplifier's frequency response select a 0dB sine wave at 1kHz. Adjust the amplitude and the amplifier gain for a + 20dB level at amplifier output. Slowly decrease the frequency, recording amplitude and frequency of any point at which the gain deviates from +20dB by more than ±0.2dB. Continue decreasing in frequency while recording the –3dB point and all –5dB steps thereafter. Reset the Instrument to 1kHz and adjust upward in frequency, proceeding as outlined above. The frequency difference between the –3dB points is defined as the amplifier's bandwidth. Figure 6-4B shows a typical frequency response characteristic.

6.5.4 A triangle wave is used to test the amplifier's gain linearity. Apply a triangular wave at 100Hz to the amplifier input. Adjust the Instrument amplitude and amplifier gain for a full screen 40 volt p-p amplitude as observed on the oscilloscope. Adjust the time base and position it so that the positive going slope of the waveform diagonally intersects the graticle lines. Repeat the above procedure for 1kHz, 5kHz, 10kHz and 20kHz. Any deviations from a straight line diagonal indicates a non-linear gain characteristic as shown in Figure 6-4C.

6.5.5 The spectral composition of a square wave is a series of odd-ordered harmonic sine waves. Therefore, a square wave is composed of a large number of harmonically-related sine waves that are in definite phase and amplitude relationship. A square wave is used for determining the transient behavior of an amplifier as well as its ability to pass a wide range of frequency components with no phase or amplitude distortion. Apply a square wave at 100Hz to the amplifier input. Adjust the Instrument amplitude and amplifier gain for a 40 volt p-p output amplitude as observed on the oscilloscope. Figure 6-4D, waveforms 2, 3, 4, and 5, shows the effects of phase shift and low frequency gain non-linearities. Adjust

the Instrument to 10kHz. Wave forms 6, 7 and 8 illustrate three different types of distortion. Waveform 6 shows the effect of a limited high frequency response. Waveform 7 shows damped oscillation due to improper feedback design. Waveform 8 shows a slew rate limiting caused by poor high frequency response of the output transistors.

6.6 OTHER APPLICATIONS

6.6.1 The DC offset feature of the 420 can be used to bias and provide a signal to transistor amplifiers. It can also be used to determine logic threshold of digital integrated circuits.

6.6.2 The voltage-controlled oscillator (VCO) provides a means of electronically altering the output frequency of the 420. A number of discrete frequencies may be generated by switching between a series of DC levels. This can be accomplished mechanically by using a rotary switch and potentiometers or electronically by using a digital to analog converter with transistor switching.

6.6.3 Two function generators may be combined for swept-frequency analysis. An offset 0 to –5V triangular wave applied to the VCO input of the second generator will provide a 300:1 downward frequency sweep, starting at the maximum frequency setting. Downward sweeps of 1000:1 ratio may be generated if waveform symmetry in the 300:1 to 1000:1 region is not important.

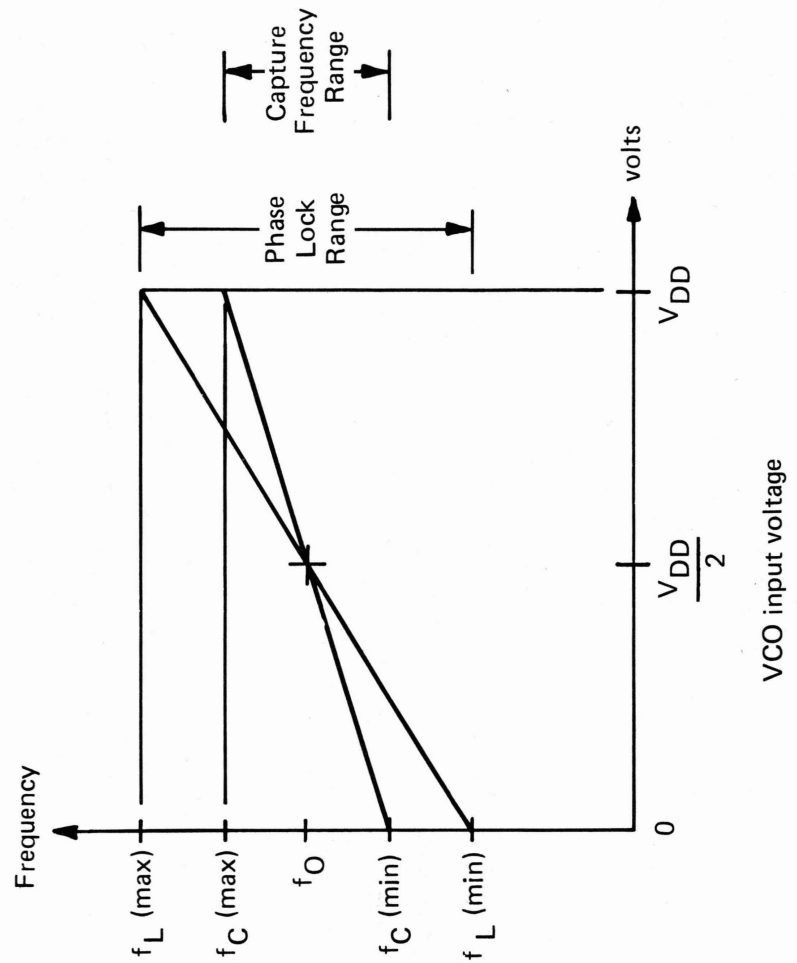


FIGURE 6-3B. PHASE-LOCKED LOOP PERFORMANCE

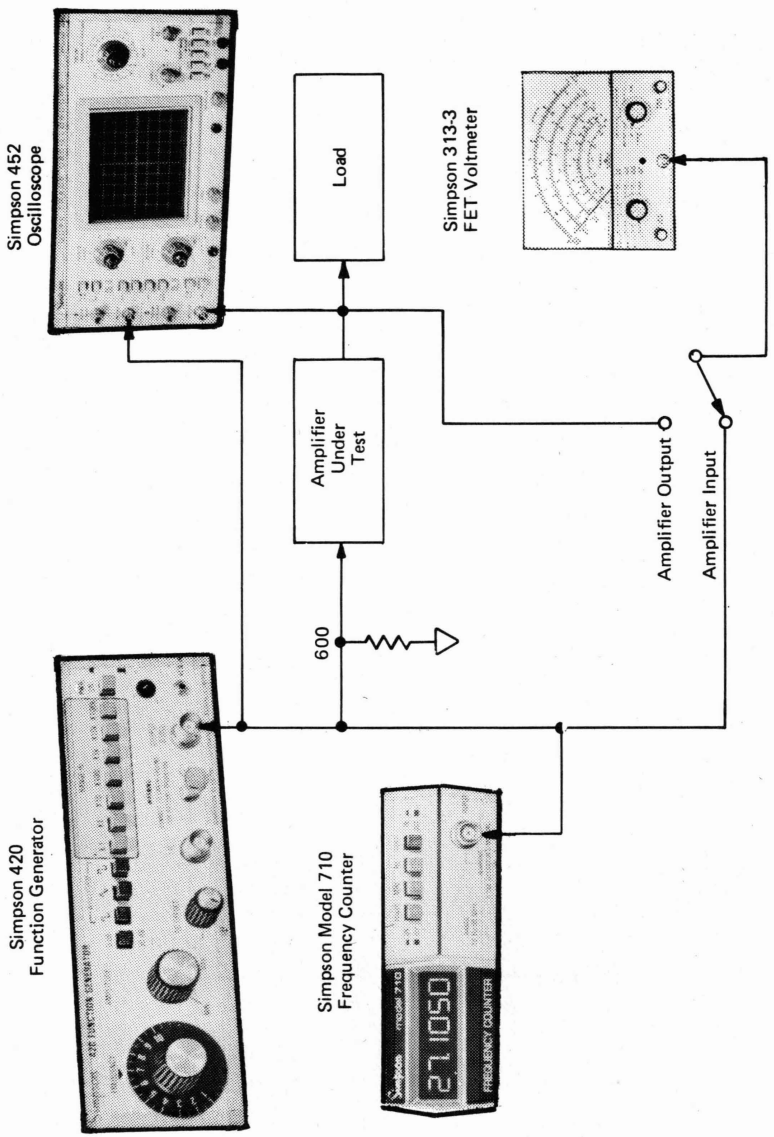


FIGURE 6-4A. AMPLIFIER TESTING

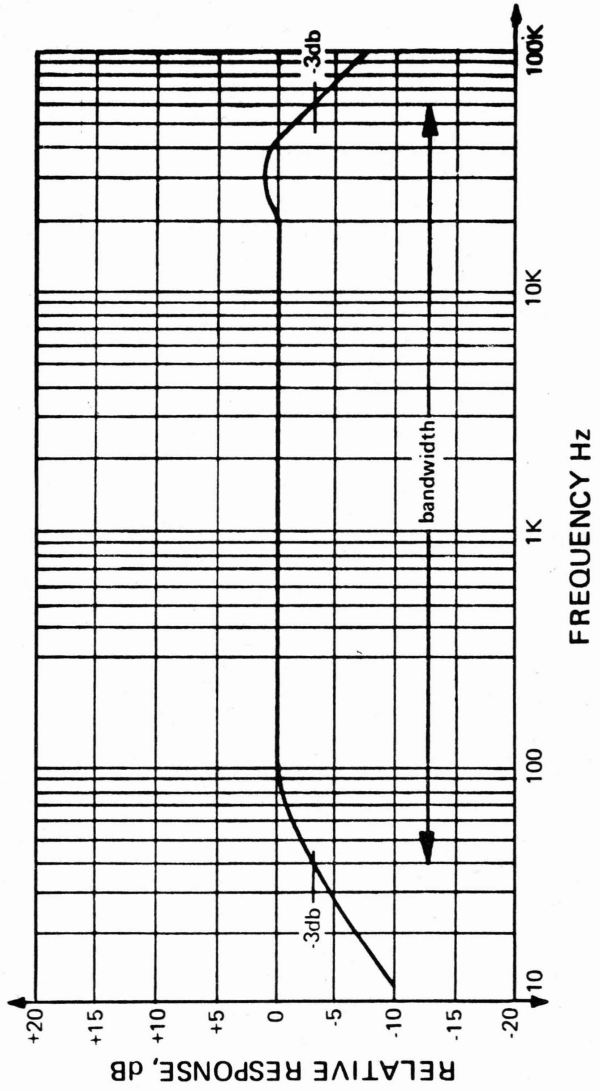


FIGURE 6-4B. FREQUENCY RESPONSE

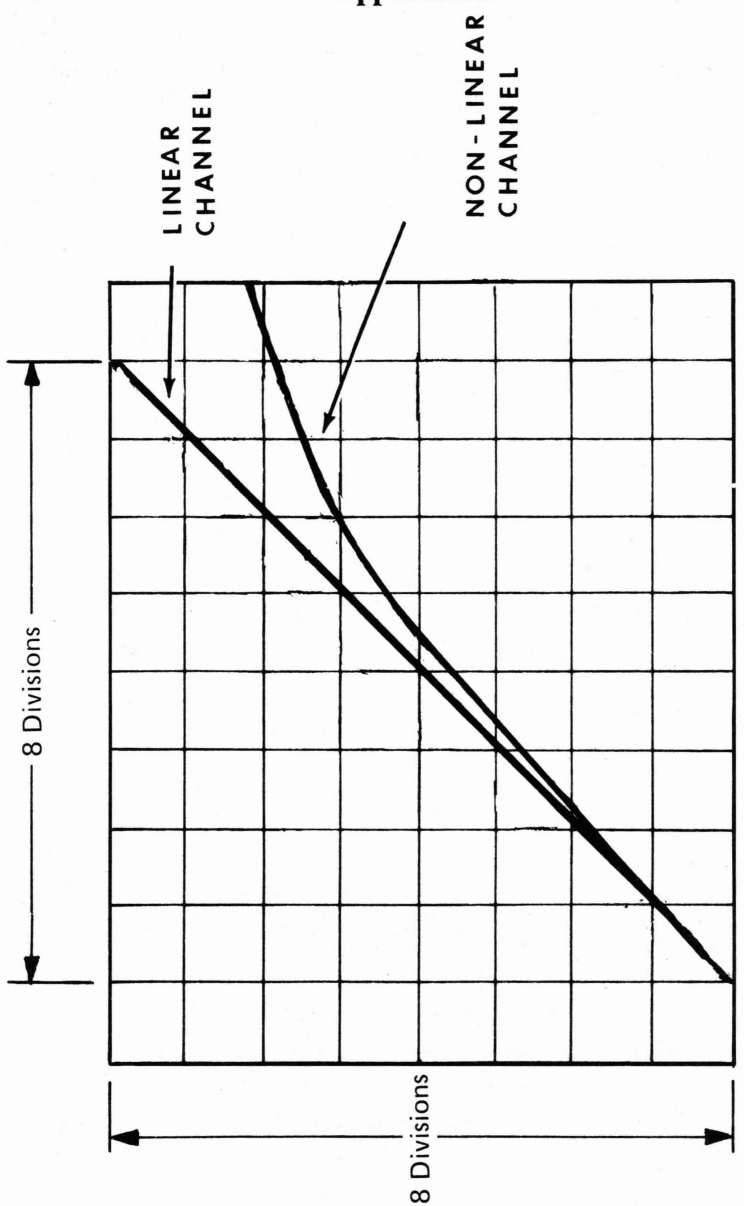


FIGURE 6-4C. CHANNEL LINEARITY TEST-TRIANGULAR WAVEFORM

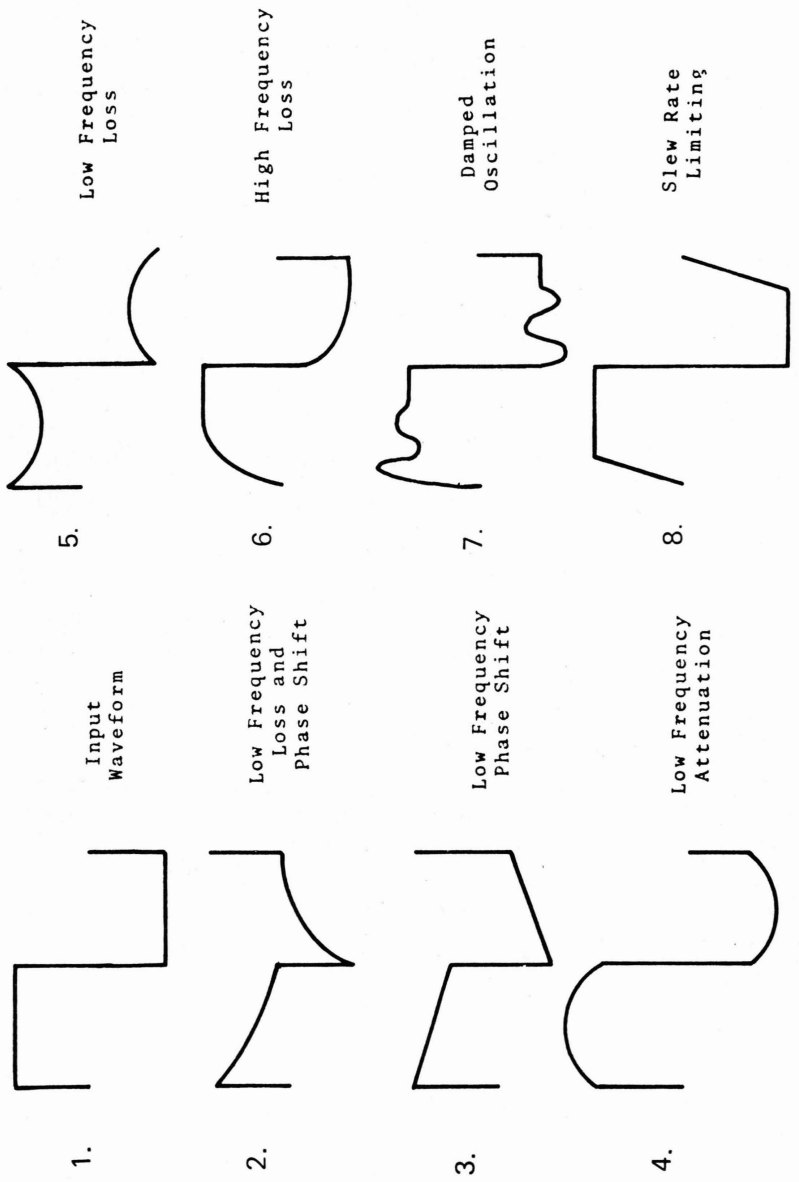


FIGURE 6-4D. SQUARE WAVE TESTING

SECTION VII
SERVICING INSTRUCTIONS

WARNING

The following Servicing Instructions are for use by qualified personnel only. To avoid electrical shock, do not perform any servicing other than that contained in the operating instructions unless you are qualified to do so.

7.1 GENERAL

7.1.1 This section describes the necessary procedures needed to effectively service the 420. Follow these instructions carefully.

7.2 COVER REMOVAL

7.2.1 The bottom cover can be removed for servicing purposes by the following procedures:

WARNING

Remove all power and connections to the Instrument before removing the case cover. Do not operate the Instrument with the bottom cover removed.

a. Depress the POWER switch to the (OFF) position.
b. Disconnect the line cord from the power source and all connections from the Instrument.
c. Pull out the knobs (on sides) of Instrument and raise the handle toward the rear of the Instrument.
d. Turn the Instrument over and remove the four (4) screws within the rubber grommets.
e. Lift bottom cover and remove handle.
f. Reverse this procedure when replacing the cover.

7.3 BATTERY INSTALLATION (420D only)

7.3.1 Refer to Tables (1-1 & 7-1) for battery specifications.

CAUTION

To avoid dangers associated with recharging batteries, use only the type specified in Table 1-1. Do not attempt to use cadmium zinc, alkaline or the like that is not designed to be recharged.

7.3.2 Install the cells as follows:

a. Remove bottom cover (para 7-2) holder.
   Then install the four cells into the holder.
   Ensure that the cells are installed according to the polarity orientation designated on the battery holder label. Failure to do so can damage the 420D.

b. Check that the battery contacts are clean and making good connection.

c. Replace the bottom cover.

d. For battery recharging, refer to paragraph 7.4 below.

7.4 BATTERY CHARGING (420D)

7.4.1 The battery is being charged at full rate when the POWER switch is set to the OFF position and AC power is applied to the Instrument. Approximately 16 hours are required to fully charge the battery in this mode of operation.

NOTE: If the battery voltage is low, charge the battery with the POWER switch set to OFF for at least 15 minutes before operating the Instrument.

7.4.2 The battery is being "trickle" charged whenever the Instrument is operated by the AC powerline.

7.5 BATTERY CARE

7.5.1 Avoid discharging the batteries completely. Charge batteries whenever the voltage is close to or below +4.7 volts.

7.5.2 Do not allow a battery to fully discharge. A completely discharged battery will eventually become inoperative if allowed to discharge repeatedly. In such a case, replacement will be necessary.

7.5.3 Do not operate the Instrument with discharged batteries. Make sure to recharge all newly purchased batteries (paragraph 7.4) for at least 15 minutes before operating the Instrument.

7.5.4 Whenever the line cord is not connected and the Instrument is not in use, remember to set the POWER switch to the OFF position.

7.5.5 With nickel-cadmium batteries installed in the 420D, avoid storing in an area where the temperature exceeds +60°C.

7.6 FUSE REPLACEMENT

7.6.1 The line fuse is mounted inside the fuseholders on the main P C Board as shown in Figure 7-1. Use the following procedure to replace a fuse.

WARNING

Remove all power and input/output connections to the Instrument before removing bottom cover. Do not replace a blown fuse with one which has a larger rating or slower time lag characteristic than those specified.

7.7 CARE

WARNING

Do not attempt to clean this Instrument with the test leads connected to a power source or when it is connected to the AC powerline.

7.7.1 Immediately clean all spilled materials from the Instrument and wipe dry. If necessary, moisten a cloth with soap and water to clean plastic surfaces.

7.7.2 Whenever possible, avoid exposure or usage in areas which are subject to temperature and humidity extremes, vibration or mechanical shock, dust or corrosive fumes or strong electrical or electromagnetic interferences.

7.7.3 Monthly Care: Verify Instrument calibration by performing operational checks using known value sources. If the need for calibration is indicated, contact the nearest Authorized Service Center.

7.7.4 Annual Care: It is recommended that the Instrument be returned annually to an Authorized Service Center or the factory for a complete overall check and calibration.

7.7.5 Storage: When the Instrument is not in use, store it in a location free from temperature extremes, dust and corrosive fumes, and mechanical vibration or shock.

7.8 REPLACEMENT PARTS AND SCHEMATIC DIAGRAM

7.8.1 The following (Table 7-1) lists part in alphanumeric order of their reference designators and indicates their description. (Refer to Table 1-2 for Items and Accessories Furnished With These Instruments.)

7.8.2 To obtain replacement parts, address order to the nearest Authorized Service Center (listed on the last pages of this manual). Refer to paragraph 2.4.1 for ordering instructions.

TABLE 7-1. REPLACEMENT PARTS

( ) = Parts used on 420A only

[ ] = Parts used on 420D only

All other parts are common to both models.

Symbol	Description	Part No.
	Battery, Eveready CH 1.8 or equivalent (ea. battery is rated at 1.25 V, 1.8 amp-hrs.)	
	Fuse ¼ A, 250V 3AG	1-113835
	Fuse Clip	5-117739
C1	Capacitor, 3μF ±2%, 100V	6-111369
C2	Capacitor, .33μF ±2%, 100V	6-111948
C3	Capacitor, .033μF ±2%, 100V	6-111947
C4	Capacitor, 3000pF ±2.5%, 33V	6-111946
C5	Capacitor, Variable, 5.5-60pF	5-116235
C6	Capacitor, 270pF ±5%, 100V	6-113286
C7, C8	Capacitor, .01μF ±20%, 50V	5-117969
C9	Capacitor, 1000pF ±20%, 1kV	1-119959
C10	Capacitor, 180pF ±10%, 50V	6-111944
C11, C33	Capacitor, 560pF ±20%, 500V	5-112695
C12	Capacitor, .01μF ±20%, 50V	5-117969
C13	Capacitor, 47μF +50% −10%, 10V	5-118498
C14	Capacitor, 1μF +80% −10%, 50V	5-119660
C15, C16, C17, C18	Capacitor, 220μF +50% −10%, 25V	6-111949
C19, C20	Capacitor, 22μF +50% −10%, 16V	6-110774
C21	Capacitor, .01μF ±20%, 50V	5-117969
C22	Capacitor, 180pF ±10%, 50V	6-111944
C23	Capacitor, .01μF ±20%, 50V	5-117969
C24	Capacitor, 47μF +50% −10%, 10V	5-118498
C25	Capacitor, 2200μF +50% −10%, 16V	5-118084

Symbol	Description	Part No.
C26	Capacitor, 10μF 16V	5-118426
C27	Capacitor, 100μF 10V	5-117050
C28	Capacitor, .022μF ±20%, 100V	5-116188
C29	Capacitor, 1000pF, 1kV	5-111119
C30, C31	Capacitor, 100uF 20V	6-110306
C32	Capacitor, 47μF +50% —10%, 10V	5-118498
C34	Capacitor, .003μF, 50V	6-111371
D1, D2, D3, D4, D5, D6, D7, D8, D9, D10, D11, D12, D13, D14	Diode, 1N4148	5-115214
	Diode, 1N4002	5-113201
D16, D17	Diode, 1N4148	5-115214
D18, D19, D20	Diode, 1N4001	5-113200
D21, D22	Diode, 1N914	5-112004
Z01	Zener Diode, 1N5232B	6-111413
Z02	Zener Diode, 1N753A	5-112634
	Rectifier, Full Wave Bridge, W005	5-115945
	Light Emitting Diode, MV5025	5-116206
IC1	Integrated Circuit, LM3046N	5-119447
IC2	Integrated Circuit,	
	LM1458N ("A" Version)	5-117432
	LM1558N ["D" Version]	6-112107
IC3	Integrated Circuit, LM319N	6-111950
IC4	Integrated Circuit, DM7400N	5-118317
IC5	Integrated Circuit, 78L12A	6-111110
IC6	Integrated Circuit, 78L05A	6-111951
IC7	Integrated Circuit,	
	LM1458N ("A" Version)	5-117432
	LM1558N ["D" Version]	6-112107
IC8	Integrated Circuit, LM3046N	5-119447
IC9	Integrated Circuit, LM741CN	5-115928

Symbol	Description	Part No.
Q1	Transistor, 2N4126	5-116458
Q2	Transistor, 2N4338	5-119216
Q3	Transistor, 2N5828	5-117065
Q4	Transistor, 2N4126	5-116458
Q5	Transistor, 2N5828	5-117065
Q6	Transistor, 2N4126	5-116458
Q7, Q8	Transistor, 2N5828	5-117065
Q9	Transistor, 2N4121	5-115939
Q10	Transistor, 2N5828	5-117065
Q11	Transistor, 2N4121	5-115939
Q13	Transistor, D40D1	5-117342
Q14, Q15	Transistor, GET 2222	5-115934
Q16, Q17	Transistor, 2N5828	5-117065
R1	Resistor, 4K ±1%, ½W	5-114835
R2	Resistor, 3.9K ±5%, ¼W	5-114974
R3	Resistor, 100Ω ±5%, ¼W	5-118152
R4	Resistor, 3.9K ±5%, ¼W	5-114974
R5	Resistor, 2K ±5%, ¼W	6-110093
R6, R7	Resistor, 10K ±5%, ¼W	5-118161
R8	Resistor, 6.8K ±5%, ¼W	5-118256
R9	Resistor, 2K ±1%, ⅛W	5-115500
R10	Resistor, 4.87K ±1%, ⅛W	6-110551
R11	Resistor, 510K ±5%, ¼W	6-110844
R12	Resistor, 2K ±1%, ⅛W	5-115500
R13	Resistor, 2K ±5%, ¼W	6-110093
R14	Resistor, 200Ω ±1%, ⅛W	5-119741
R15	Resistor, 1.96K ±1%, ⅛W	6-111965
R16	Resistor, 19.6K ±1%, ⅛W	5-116504
R17, R18	Resistor, 10Ω ±5%, ¼W	5-119670
R19	Resistor, 2K ±5%, ¼W	6-110093
R20	Resistor, 56K ±5%, ¼W	5-118167

Symbol	Description	Part No.
R21	Resistor, 20K ±1%, ⅛W	5-116621
R22	Resistor, 1K ±1%, ⅛W	1-117058
R24, R25	Resistor, 1K ±5%, ¼W	5-118155
R26	Resistor, 200Ω ±5%, ¼W	5-119740
R27	Resistor, 1K ±1%, ⅛W	1-117058
R28	Resistor, 20K ±1%, ⅛W	5-116621
R29	Resistor, 1K ±5%, ¼W	5-118155
R30	Resistor, 510Ω ±5%, ¼W	5-114965
R31	Resistor, 10K ±5%, ¼W	5-118161
R32	Resistor, 300Ω ±5%, ¼W	5-119630
R33	Resistor, 1K ±5%, ¼W	5-118155
R34	Resistor, 20K ±5%, ¼W	5-119645
R35	Resistor, 1K ±5%, ¼W	5-118155
R36	Resistor, 3.9K ±5%, ¼W	5-114974
R37, R38, R39	Resistor, 100Ω ±5%, ¼W	5-118152
R40, R41	Resistor, 20K ±1%, ⅛W	5-116621
R42	Resistor, 2K ±1%, ⅛W	5-115500
R43	Resistor, 332Ω ±1%, ⅛W	5-118047
R44	Resistor, 750Ω ±5%, ¼W	5-119760
R45, R46	Resistor, 1K ±5%, ¼W	5-118155
R47	Resistor, 3.9K ±5%, ¼W	5-114974
R48	Resistor, 300 Ohm ±5%, ¼W	5-119620
R49	Resistor, 100K ±5%, ¼W	5-118168
R50	Resistor, 750Ω ±5%, ¼W	5-119760
R51	Resistor, 20K ±5%, ¼W	5-119645
R52, R85	Resistor, 6.8K ±5%, ¼W	5-118256
R53	Resistor, 10Ω ±5%, ¼W	5-119670
R54	Resistor, 200Ω ±5%, ¼W	5-119740
R55	Resistor, 10Ω ±5%, ¼W	5-119670
R56	Resistor, 750Ω ±5%, ¼W	5-119760

Symbol	Description	Part No.
R57	Resistor, 100Ω ±5%, ¼W	5-118152
R58, R59	Resistor, 200Ω ±5%, ¼W	5-119740
R60	Resistor, 5.6K ±5%, ¼W	5-118257
R61	Resistor, 750Ω ±5%, ¼W	5-119760
R62, R63, R85	Resistor, 6.8 ±5%, ¼W	5-118256
R64	Resistor, 100K ±5%, ¼W	5-118168
R65	Resistor, 22Ω ±5%, ¼W	5-115509
R66, R67	Resistor, 300Ω ±5%, ¼W	5-119630
R68	Resistor, 22Ω ±5%, ¼W	5-115509
R69	Resistor, 300Ω ±5%, ¼W	5-119630
R70	Resistor, 3.9K ±5%, ¼W	5-114974
R71	Resistor, 300Ω ±5%, ¼W	5-119630
R72	Resistor, 3.9K ±5%, ¼W	5-114974
R73	Resistor, 680Ω ±5%, ¼W	5-119634
R74	Resistor, 390Ω ±5%, ¼W	5-118420
R75	Resistor, 18K ±5%, ¼W	5-115512
R76	Resistor, 62Ω ±5%, ½W	6-112004
R77, R78	Resistor, 0.5Ω ±1%, 1W	5-113998
R79	Resistor, 22Ω ±5%, ¼W	5-115509
R80	Resistor, 1K ±5%, ¼W	5-118155
R81	Resistor, 10K ±5%, ¼W	5-118161
R82	Resistor, 5.6K ±5%, ¼W	5-118257
R83	Resistor, 15K ±5%, ¼W	5-118162
R84	Resistor, 510K ±5%, ¼W	6-110844
VR1	Potentiometer, 5K ½W	6-111943
VR2	Potentiometer, 5K .2W	5-119773
VR3	Potentiometer, 100K .2W	5-118175
VR6	Potentiometer, 100Ω .2W	5-119770
VR7	Potentiometer, 100K .2W	5-118175
VR8	Potentiometer, 1K .2W	5-119649
VR9, VR10	Potentiometer, 5K .2W	5-119773

Replacement Parts

Symbol	Description	Part No.
VR11	Potentiometer, 5K ½W	6-111943
VR12, SW2	Potentiometer, 50K, ¼W w/Switch	5-119779
VR13	Potentiometer, 100K .2W	5-118175
VR14	Potentiometer, 1K .1W	5-116185
VR15	Potentiometer, 5K .2W	5-119773
SW1	Switch, Push Button, 12 Positions	6-111952
T1	Power Transformer	
	("A" Version)	6-111953
	["D" Version]	5-119391
T2	DC-DC Converter Transformer	5-118377
	Button, Red	6-110113
	Button, Gray	6-110115
	Button, Black	6-110114
	Fuse Clip	5-117739
	Heat Sink	5-118657
	Battery Holder	6-111960
	Bracket Assembly, Power Connector	10-863216
	Panel Assembly	10-864544
	BNC Connector	5-111622
	Connector, Jack	5-117326
	Binding Post	6-111955
	Case Assembly, Top (420A)	10-864543
	Case, Bottom	3-320460
	Handle	5-118375
	Plate, Insert, Handle	5-118398
	Bumper, Rubber Foot	1-117829
	Cover, Transformer	3-261059
	Knob, ⅛" Dia. Bushing	5-118140
	Knob, ¼" Dia. Bushing	6-111941
	Knob, Frequency Indicator	6-111977

NOTES

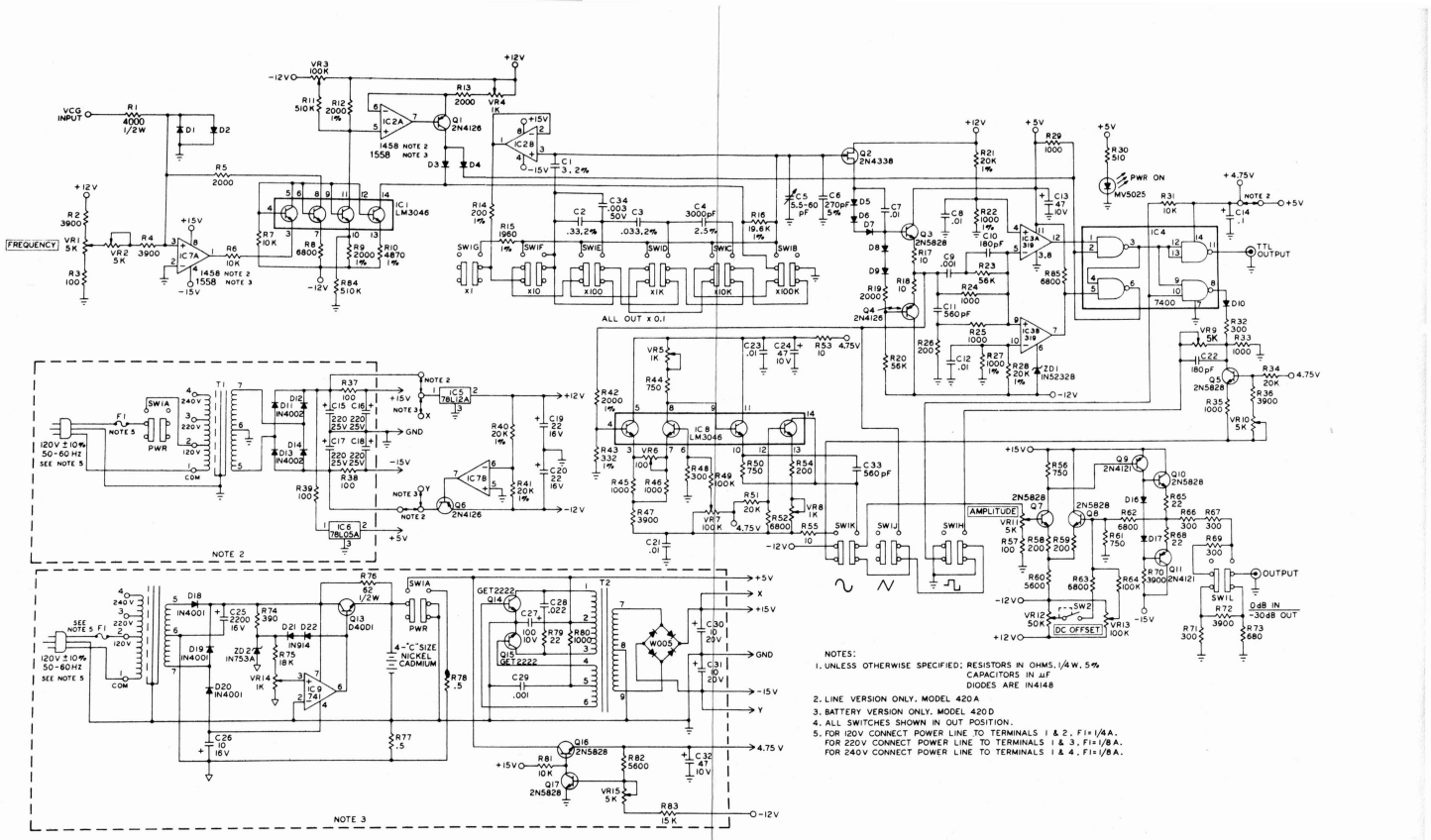

FREQUENCY
VCG INPUT
ALL OUT x 0.1
NOTE 2
NOTE 3
AMPLITUDE
DC OFFSET
PWR ON
TTL OUTPUT
OUTPUT
-30dB OUT
NICKEL CADMIUM
120V ± 10% 50-60 HZ SEE NOTE 5
SEE NOTE 5
NOTES:
1. UNLESS OTHERWISE SPECIFIED: RESISTORS IN OHMS, 1/4 W, 5% CAPACITORS IN µF DIODES ARE IN4148
2. LINE VERSION ONLY, MODEL 420A
3. BATTERY VERSION ONLY, MODEL 420D
4. ALL SWITCHES SHOWN IN OUT POSITION.
5. FOR 120V CONNECT POWER LINE TO TERMINALS 1 & 2, F1=1/4A. FOR 220V CONNECT POWER LINE TO TERMINALS 1 & 3, F1=1/8A. FOR 240V CONNECT POWER LINE TO TERMINALS 1 & 4, F1=1/8A.

FIGURE 7-1. SCHEMATIC DIAGRAM

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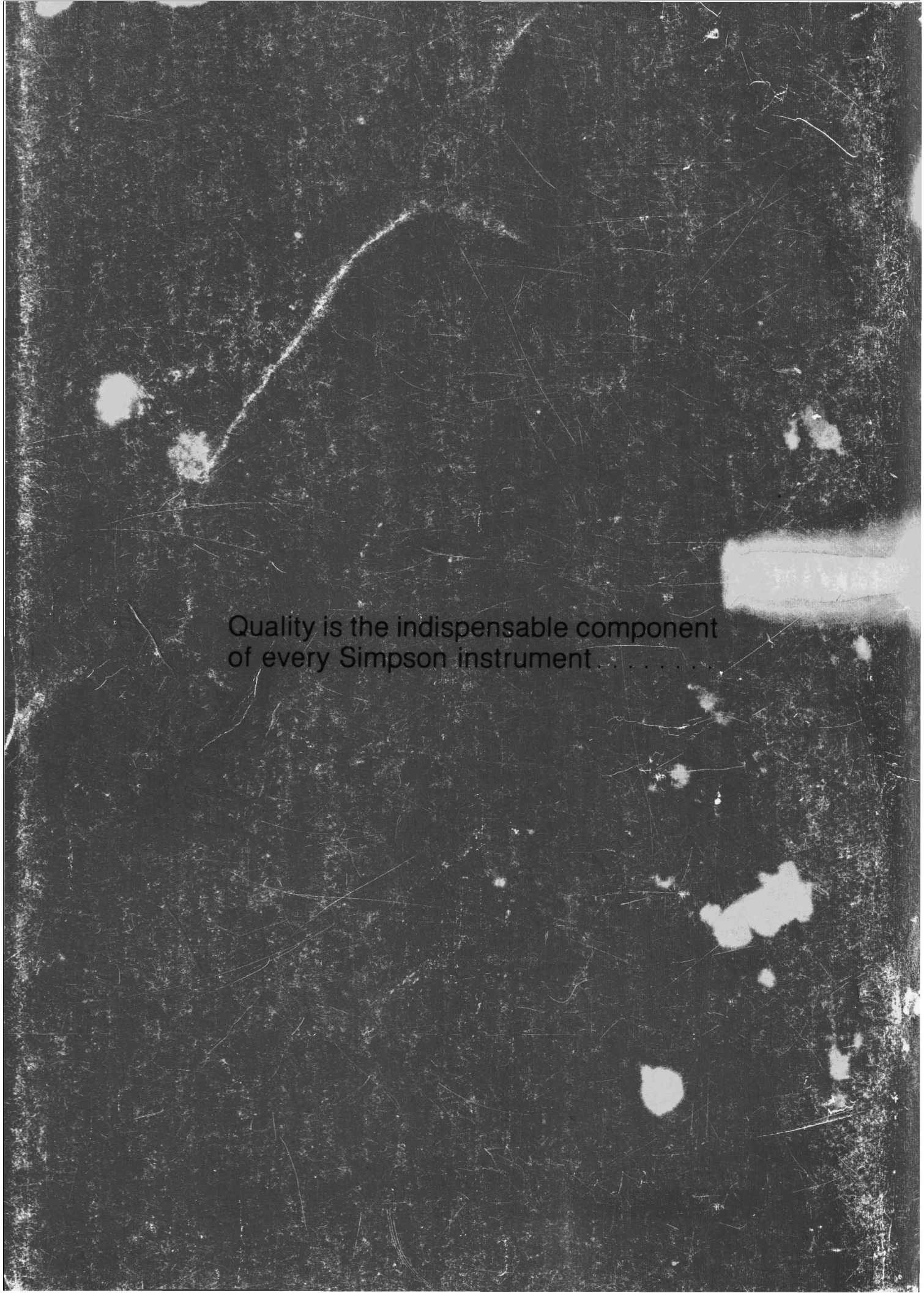
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